



COVID-19: NEGATIVE PRESSURE ROOMS

Author: Dr Micah DJ Peters

Date: August 14 2020

Question: What is the best available evidence regarding the use of negative pressure rooms for care of COVID-19 patients?

***ALERT* Evidence regarding COVID-19 is continually evolving. This Evidence Brief will be updated regularly to reflect new emerging evidence but may not always include the very latest evidence in real-time.**

Key messages:

- Isolation rooms, including negative pressure rooms, are designed to control the airflow in the room so that the number of airborne infectious particles is reduced to a level that diminishes the risk of cross-infection of others.
- Negative room air pressure is designed to protect others outside the room from any airborne transmission from a patient who may be an infection risk inside the room.
- Health and aged care workers should be aware that, uncovered, coughing and sneezing, and in some instances, speaking can generate small droplets and aerosols that may travel several metres, remain airborne, and collect on surfaces. While the infection risk, particularly of smaller aerosolised particles, is as yet not well understood, this highlights the importance of careful risk assessment and infection control measures for airborne transmission risk particularly in crowded, poorly ventilated, indoor environments.
- Personal protective equipment precautions for airborne transmission should be observed in high-risk areas e.g. (ICU, COVID-19 wards, negative pressure rooms) where aerosol generating procedures take place including collection of respiratory samples including for asymptomatic patients (bronchoalveolar lavage and induced sputum), and when providing frequent and/or close-contact care for people with suspected or confirmed COVID-19.
- Patients should be placed in a negative pressure room if an aerosol generating procedure is to be performed.
- If available, negative pressure rooms should be used for the collection of respiratory samples from patients with suspected COVID-19.
- In Australia, negative pressure rooms should comply with the guidelines outlined by the Australasian Health Infrastructure Alliance.
- In the absence of negative pressure rooms, newly developed intensive care ventilation hoods, some of which are able to maintain small negative pressure environments around a patient's head and upper body, may reduce the potential for the spread of aerosolised droplets. As with all new technologies, there must be careful consideration of safe and effective use.

Summary

Background: COVID-19 (from ‘severe acute respiratory syndrome coronavirus 2’ (or ‘SARS-CoV-2’) is a newly discovered (novel) coronavirus first identified in Wuhan, Hubei province, China in 2019 as the cause of a cluster of pneumonia cases.¹ Coronaviruses are similar to a number of human and animal pathogens including some of those which cause the common cold as well as more serious illnesses including severe acute respiratory syndrome (SARS/ SARS-CoV-1) and Middle East respiratory syndrome (MERS). Since discovery, COVID-19 has spread to many countries and was declared a global emergency by the World Health Organization (WHO) on 30 January 2020,² and a pandemic on March 11.³

There is ongoing research and debate regarding the degree to which smaller respiratory droplets contribute to the spread of COVID-19.⁴ Many jurisdictions nationally and globally have now adopted infection control measures for the management of airborne transmission based on emerging evidence and pressure to strengthen infection control and protection policies.^{5,6}

The individuals most at-risk of infection are those in close contact with patients with COVID-19 which includes health and aged care workers. Use of negative pressure rooms, which prevent air from circulating to other areas in the building, are recommended where available, to minimise the potential risk of transmission via smaller respiratory droplets.⁶ Negative pressure rooms have been recommended since early on during the pandemic in the context of aerosol generating procedures and the collection of respiratory samples where possible.

COVID-19 transmission: droplets, surfaces, and aerosols

Based on currently available evidence, COVID-19 is transmitted when the virus enters the body via the mucosae (mouth and nose) or conjunctiva (eyes) which can occur through;⁴

- direct person-to-person contact via saliva and/or mucus,
- respiratory droplets >5-10µm in diameter (e.g. from coughing and sneezing),
- indirect contact from touching infected environmental surfaces/formites and transferring viral particles to the mucosae or conjunctiva, and;
- smaller (<5µm) respiratory droplets (aerosols).

There is ongoing inquiry regarding the relative contribution of each of the above infection pathways to the overall spread of the virus. To date, evidence suggests that while possible, the transmission of viral particles in aerosolised droplets (<5µm) is unlikely to be the most common form of transmission. Evidence for COVID-19 transmission is continually evolving particularly around the potential for ‘airborne’ transmission.⁷

It is important to recognise that both large and smaller droplets travel through the air and may be considered ‘airborne’, however smaller droplets behave differently to larger droplets as they are lighter, more buoyant, and evaporate more quickly. The science regarding the airborne transmission of disease is itself complex and equivocal. Questions remain regarding virology (i.e. what amount of a virus is enough to cause an infection?) and biophysics (i.e. how do particles move in the air under different conditions?).⁸ The SARS-CoV-2 may be found in small, aerosolised particles,⁹ but the extent to which these smaller particles pose an infection risk or how they move in the air under different conditions is currently unconfirmed.⁸

For further summarised information regarding the transmission of COVID-19 and selection and use of personal protective equipment (PPE) please see:

[Evidence Brief: COVID-19 Modes of Transmission and Infection](#)

[Evidence Brief: COVID-19 Personal Protective Equipment](#)

Aerosol generating procedures

Various clinical procedures can generate aerosolised particles which may lead to risk of infection.⁴ Generally, these procedures are conducted in intensive care units, COVID-19 dedicated wards, and in isolation rooms which could be understood as high-risk environments. Exposure to aerosolised particles may include both those directly undertaking aerosol generating procedures, as well as those in the same areas where such procedures occur.⁹ Different jurisdictions around the world have varying guidance regarding what is classed as an aerosol generating procedure. In Australia, in the context of COVID-19, aerosol generating procedures are defined under the following categories:⁶

Instrumentation or surgical procedures on the respiratory tract:

- Insertion or removal of endotracheal tube and related procedures e.g. manual ventilation and open suctioning of the respiratory tract
- Bronchoscopy and upper airway procedures that involve open suctioning
- Tracheotomy/tracheostomy (insertion, removal, open suctioning)
- Ear-nose-throat, faciomaxillary or transphenoidal surgery; thoracic surgery involving the lung
- Post-mortem procedures involving high speed devices on the respiratory tract
- Intentional or inadvertent disconnection/reconnection of closed ventilator circuit

Other procedures that can generate respiratory aerosols:

- Manual or non-invasive ventilation (NIV): bi-level positive airway pressure ventilation (biPAP); continuous positive airway pressure ventilation (CPAP)
- Collection of induced sputum
- High flow nasal oxygen
- Upper gastrointestinal instrumentation that involves open suctioning of URT
- Some dental procedures e.g. involving high speed drilling
- Cardiopulmonary resuscitation (CPR)*

Further, the Australian guidance cautions against the use of nebulisers and alternative means of delivering medication should be used (such as a spacer). Collection of respiratory specimens may also result in aerosol production including bronchoalveolar lavage and induced sputum for any patient (including asymptomatic) and any respiratory sample collection procedure with fever, breathlessness and/or severe cough.

Negative pressure rooms

In Australia, negative pressure rooms are one type of isolation room (Class N).¹⁰ It is a single room with an ensuite that is not shared. It is used for patients who require isolation to reduce airborne transmission of disease. The Australian Government Department of Health recommends that if available, negative pressure rooms should be used for;⁶

- Isolation of hospitalised patients with severe acute respiratory symptoms, and/or probable, or confirmed COVID-19 infection,
- Aerosol generating procedures[^] with presenting patients (general practice, hospital, emergency department, clinic, or pathology collection centre) with acute respiratory symptoms, and/or suspected, probable, or confirmed COVID-19 infection.

* As an emergency, life-saving procedure special consideration is warranted for CPR and should not be delayed. While a 'high risk' procedure in terms of infection risk, evidence appears equivocal. There is differing guidance regarding the use of contact/droplet precautions versus airborne precautions, however airborne precautions may provide additional protection.

[^] Including collection of induced sputum

In the absence of a negative pressure room, an empty, well-ventilated room with the door closed should be used.⁶ Negative pressure rooms have special seals to prevent inadvertent escape of pathogens, therefore with no ventilation in the event of sustained power failure; isolation of airborne patients with infectious conditions becomes a patient safety risk. As determined by the Australasian Health Infrastructure Alliance, a negative pressure room must include:

- a Type-B hand basin within the room
- self-closing door
- sufficient and appropriate storage for clinical waste
- separate entry doors to allow for movement of the patient in and out of the room.
- an anteroom for use only by staff and visitors.
- an air handling system that operates at a lower pressure with respect to adjacent areas such as the anteroom and corridor
- exhausted air to the outside in accordance with AS 1668.2 to prevent air recirculation
- an air supply should be located on the ceiling above the foot of the bed
- exhaust air to be located at the head of the bed
- air discharge points located as far as possible from air intakes and from where people congregate or work
- recirculated through HEPA filters if external exhaust is not possible
- provision of a dedicated exhaust system to each room, separate to the common exhaust air system
- connection to the emergency backup power in case of power failure

Intensive care ventilation hoods

Intensive care ventilation hoods, also known as isolation biohazard hoods, personal ventilation hoods and other similar names are relatively newly developed devices that cover a patient's head and upper body with a transparent tent-like barrier creating a protected micro-environment that reduces the potential for droplets, including smaller aerosolised droplets, to escape into the surrounding environment.¹¹ Groups around the world have developed various versions of this new technology which in some cases has entered clinical practice while still undergoing testing.¹²

Some of these devices use vacuum systems to generate small negative pressure environments where it may be more suitable to conduct aerosol generating procedures or to house the patient where traditional negative pressure rooms are unavailable.¹³ Some authors have expressed concern regarding the use and safety of these devices, highlighting a number of potential clinical and infection control considerations that should be considered when using these devices including the risk of infection when using PPE, disruption of visibility during clinical procedures, and the proper implementation and use of the device.¹⁴

References

1. World Health Organization. Rolling updates on coronavirus disease (COVID-19). 2020. <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/events-as-they-happen> (accessed 25 Mar 2020).
2. World Health Organization. Director-General's remarks at the media briefing on 2019-nCoV on 11 February 2020. 2020. <https://www.who.int/dg/speeches/detail/who-director-general-s-remarks-at-the-media-briefing-on-2019-ncov-on-11-february-2020> (accessed Mar 25 2020).
3. World Health Organization (WHO). WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020. 11 Mar 2020. <https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19--11-march-2020> (accessed 10 Jul 2020).
4. World Health Organization (WHO). Scientific Brief: Modes of transmission of virus causing COVID-19: implications for IPC precaution recommendations. 29 Mar 2020. 29 Mar 2020 2020. <https://www.who.int/news-room/commentaries/detail/modes-of-transmission-of-virus-causing-covid-19-implications-for-ipc-precaution-recommendations> (accessed 5 Apr 2020).
5. Queensland Health. Interim infection prevention and control guidelines for the management of COVID-19 in healthcare settings Version 1.13. 24 June 2020 2020. https://www.health.qld.gov.au/data/assets/pdf_file/0038/939656/gh-covid-19-Infection-control-guidelines.pdf (accessed 14 Aug 2020).
6. Communicable Diseases Network Australia. Coronavirus Disease 2019 (COVID-19) CDNA National Guidelines for Public Health Units Version 3.7. 12 Aug 2020 2020. [https://www1.health.gov.au/internet/main/publishing.nsf/Content/7A8654A8CB144F5FCA2584F8001F91E2/\\$File/COVID-19-SoNG-v3.7.pdf](https://www1.health.gov.au/internet/main/publishing.nsf/Content/7A8654A8CB144F5FCA2584F8001F91E2/$File/COVID-19-SoNG-v3.7.pdf) (accessed 14 Aug 2020).
7. Buonanno G, Morawska L, Stabile L. Quantitative assessment of the risk of airborne transmission of SARS-CoV-2 infection: prospective and retrospective applications. *medRxiv* 2020: 2020.06.01.20118984.
8. Asadi S, Bouvier N, Wexler AS, Ristenpart WD. The coronavirus pandemic and aerosols: Does COVID-19 transmit via expiratory particles? *Aerosol Science and Technology* 2020; **54**(6): 635-8.
9. Guo ZD, Wang ZY, Zhang SF, et al. Aerosol and Surface Distribution of Severe Acute Respiratory Syndrome Coronavirus 2 in Hospital Wards, Wuhan, China, 2020. *Emerging infectious diseases* 2020; **26**(7): 1583-91.
10. Australian Health Infrastructure Alliance. Australasian Health Facility Guidelines Part D - Infection Prevention and Control. 1 Mar 2016 2016. https://aushfg-prod-com-au.s3.amazonaws.com/Part%20D%20Whole_7_2.pdf (accessed 14 Aug 2020).
11. Convissar D, Chang CY, Choi WE, Chang MG, Bittner EA. The Vacuum Assisted Negative Pressure Isolation Hood (VANISH) System: Novel Application of the Stryker Neptune™ Suction Machine to Create COVID-19 Negative Pressure Isolation Environments. *Cureus* 2020; **12**(5): e8126-e.
12. McGain F, Humphries RS, Lee JH, et al. Aerosol generation related to respiratory interventions and the effectiveness of a personal ventilation hood. *Critical care and resuscitation: journal of the Australasian Academy of Critical Care Medicine* 2020.
13. Rajajee V, Williamson CA. Use of a Novel Negative-Pressure Tent During Bedside Tracheostomy in COVID-19 Patients. *Neurocrit Care* 2020: 1-7.
14. Jain U. Caution Regarding Enclosures for Airway Procedures. *Anesth Analg* 2020: 10.1213/ANE.0000000000004983.